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of perfection, both the chronological and geographical relations of history, is a practical impossibility. This ideal chart, however, which we have been compelled so cavalierly to dismiss, leaves us one legacy of practical value, namely, its cross section, which resolves itself simply into the familiar historic map, of which, as capable of representing in complete perfection contemporary historico-geographic relations at any particular moment of time, we shall gladly avail ourselves. In default, however, of any completely adequate representation combining a comprehensive view of history at once in its chronological and its geographical relations, which as we have seen appears to be absolutely unattainable, we must be content to substitute some more or less imperfect form of diagrammatic chart—the best we can devise.

On experiment it will probably be found that the most practical form our History Chart can assume will consist of the "Time-stream" represented by a lengthened roll of paper crossed by lines, the spaces between which shall represent a definite cycle of time—probably a year or ten years will be the period selected—while the geographical relations will be represented by roughly parallel longitudinal bands, expressing—inadequately it must be confessed—the definite divisions of geographical surface, to which the events to be inscribed belong.

Such a chart as have been above suggested is capable of representing graphically, and also to a large extent quantitatively, any one of the sub-divisions into which, as has been before noted, history has been divided; and it is also capable of representing them in combination. Thus all the facts usually taken notice of in general history may be displayed, so as to exhibit to the eye, with some measure of accuracy, their mutual relations of time and place. To present historical events to the eye even thus imperfectly, as will be evident to every educationist, is a large step towards rendering history something more than a mere loose chain of isolated events, and to make it more easy to introduce something of organic life into the often somewhat vague and mechanical conception produced in the mind of the learner, by the ordinary teaching of elementary history.

H. B.

THE RISE AND AIMS OF MODERN BOTANY

BY PROFESSOR PATRICK GEDDES.

(Continued from page 743.)

PHYSIOLOGY was meanwhile travelling more slowly upon the same road, descending through similar stages. For plants this took place with exceeding slowness and difficulty, owing to the prevailing systematic and anatomical bias. This may be well evidenced by the fact that even now we have only a single English treatise, and that a recent one; without going into such a melancholy story as how long Hales' classical researches on the circulation of the sap were left undeveloped, or Sprengel's "Discovered Secret of Nature" totally ignored. The full and final establishment of the physiological standpoint, instead of the merely anatomical one, has, however, been effected by Darwin. We must, therefore, think of him, for the present at any rate, not so much in connection with the famous conception of natural selection (itself an application of current philosophy) of which he made such comprehensive use; nor even in connection with the establishment of the doctrine of descent, in which he played such a leading part; but primarily as concerned with the reconcentration of all these various planes of specialism into a general view of organic (that is to say, living) nature. The science no longer centres round the dried herbarium specimen of it, as had been the case since Linnaeus's day: it has become again a living being—moving, breathing, digestive, sensitive. In a word, the Dryad of old poetry has been recalled to life by modern science—our second, and let us hope more enduring Renaissance.

This, then, brings us up to our own day and its progress. We shall soon find that each week's botanical newspaper (from Strasburg still, it is worth noting) introduces us to new masses of botanical literature, which threaten to smother us.

Hence the use of this simple record of the stages of our deepening analysis, which may now be viewed as a bookcase, or rather a couple of bookcases, respectively devoted to the literature of morphology and physiology. On each shelf we have the literature of a particular stage of our deepening study; and it will be seen that the morphological and physiological stages are parallel, although their shelves for the most part have been filled up quite independently by writers approaching from quite different sides and points of view; indeed, far too often in the dark as to the general plan and aspects of the science. At the beginning of each shelf we have the fundamental work from which a whole department of modern literature arises, and of which it may be considered as essentially a continuation (the minor predecessors leading up to each great work being also indicated). In this way all floras and enumerations of species generally, are continuations of Linnæus' *Systema Naturæ*; all histological study of the cell a continuation of Schleiden and Schwann; and so on.* In physiology and in morphology we have thus as it were a kind of pentateuch, to which all our subsequent literature must be referred—and this for the most part as of the nature of appendices, or at most of revised editions.

Hence the use of this simple historic classification. It enables us to dive into the literature of any branch of the subject at will. Guidance to each department of literature is also provided by the industry of bibliographers. Happily, too, good sectional manuals are forthcoming, but a good general text-book is still wanting—*i.e.*, one which shall set out with the conception of physiology and evolution, instead of at best concluding with a dogmatic treatment of these, after the whole anatomical analysis has been empirically gone through. The student should be taught to handle these principles from the outset, and to interpret the facts of form by their aid: this, however, is the problem of a course of lectures such as the present. For a special field of the subject treated in this way, perhaps no book is more conveniently typical than Darwin's "Insectivorous Plants." Kerner's new

* See the writer's "Synthetic Outline of the History of Biology."—*Proc. Roy. Soc. Edin.* 1886-7.—Also BIOLOGY and BOTANY—*Chambers' Encyclopædia* (New Edition 1888).

"*Pflanzenleben*" (Leipzig 1887), deserves of all general books the greatest praise, for making clear, from the very outset, the idea that the plant is really and thoroughly alive, and for maintaining that view throughout.

I had hoped to trace this history in fuller detail, and interpret it more completely in the light of that general historic evolution of which it has formed a part. We might, for instance, take special instances like that of the famous naturalist, Abbé Bonnet, a century ago, and look at him classifying all living beings into a regular unbroken scale or hierarchy (*échelle des êtres*), which no one any longer supposes to correspond to the facts of nature. How, then, is it to be explained? Essentially as the naive projection upon nature of that regular gradation from sexton to pope in which his mind was formed, and from the "bas peuple" up to the "Grand Monarque." Nor is it otherwise in our own day, with Schwendener applying (albeit more profitably) his personal acquaintance with engineering to explain the problems of vegetable mechanics; for the scientific process is always and everywhere the same. Consciously or unconsciously, "the eye only sees what it brings with it the power of seeing." Hence each contribution to science, even Darwin's own, is no completed truth, but at best such portion of the truth of nature as our general mode and theory of life (of course together with our particular stage of personal evolution) enable us to see. The whole matter is well summed by the poet and thinker whom this very day we are specially mourning—summed up for the history of our science as for the whole River of Time:—

"As is the world on its banks,
So is the mind of the man.
... only the thoughts
Raised by the objects he passes are his."

We pluck new flowers on the banks as we float, and look at these through eyes which are only childishly and slowly opening towards full intelligence. At the great drama of evolution the naturalist is but the awakening spectator.

"I observe" said a wise pope long ago, "that every generation of men is characterised by a different habit of thinking." Hence, so long as we do not finally anchor ourselves at the spot whence Dioscorides, or Linnæus, or even Darwin last looked, but sail on with the general stream of human culture

and progress, there will await us not only new discoveries, but ever-freshening points of view.

We have been a long time in getting the literature of the science into this scheme of progressively deepening analysis; but you see it is at the same time a set of pigeon-holes for present work. The study of the development of science does help us to deal with its present state. In our historic bookcase Linnæus marshals all the Linneans; Jussieu and his direct pupil Cuvier, the anatomists; and so on, similarly too, with the schools of physiologists.

The aims of our science also are becoming obvious. The simplest and commonest way for a young investigator to go to work, especially in Germany—where nowadays investigators are manufactured wholesale—is to enlist in some one school or other, which may happen to be his teacher's, or his teacher's teacher's again in turn, and work there all one's life as in a mill, often half-unconscious, or three-parts indifferent, to all the work going on around—a scientific millworker, in short. This has, of course, its useful side; but larger possibilities are becoming obvious. In the first place, we have that of being a more skilled worker, ready to turn oneself to different lines and levels; and a good monograph, like one of those of the *Challenger* expedition, does this more or less completely. Again, we may seek to sum up and generalise any one plane of research, as most simply that of species, into a classification, a genealogical tree: or similarly sum up knowledge of the function or structure of organs and tissues, of cell and protoplasm. These are, in fact, so many questions which you have to ask—but which will need separate lectures to answer. Thirdly, we can see higher possibilities beyond these. Our studies and generalisations have been so far descriptive and empirical. Can we not see a possibility of a return wave which should combine and unify all these separate generalisations, and so rationalise them; thus reaching the goal of all our separate studies, a proximate conception of the entire phenomena of life? We have now to put together our cells into tissues, these into organs, and thus rebuild the organism. Thus, then, our mental image of the plant is no longer the mere corpse of the anatomical side of things, but has become a *working thought-model* in short. Our Biology would thus have passed from the mere separate analysis of all things

dead, to the synthetic view of all things living. The naturalist is thus again like Adam in his Paradise garden—nay, happier—for he now tastes the fruits of both life and knowledge.

The deepening anatomical analysis showed us the parts of the engine, but it is for this rising physiological synthesis to put them together, to make them work. Or to use another metaphor, which also is more than a metaphor, the anatomist gives us the architectural details of the house of life; but with the physiologist we see these all put together, and in the service of the inhabitant.

You see the advantage of this library arrangement. The student can find anything, once he has this type-library in his head, and no longer needs to cram his memory to weariness, since he knows how to turn anything up in these shelves of dictionaries as it happens to be wanted. Teaching by help of a type library of this kind puts a man from the first into a rational position; it is like a small scale map beside a pile of fragmentary detailed ones—all the main things are in the first, and you can go to the others all the more easily and intelligently when you need them.

Shall we, then, collect these books and get them up? Certainly we must. That will be part of our detailed business. These books, or their modern representatives, are at once the working tools and dictionaries of the science; and familiarity with them comes far more easily than you would suppose when you take them in this rational way.

But science is not in books. No, certainly, as little as is music, for both give but the notation of a high mental state. From these bookshelves we have to gather the results of the science, and apply them practically in the actual garden: to see our flowers in all their fulness of living detail—functions and structures united into one single imaginative picture, the working thought-model aforesaid.

No sooner, then, have we collected our library and mastered its principle, than we begin to see how to escape its overmastering weight, its wholly unreadable mass. If we try to master even a single plane—the whole Linnæan, the whole Cuvierian one—the task is hopeless, and we only fall back into our narrow places as specialists once more. What is to be done?

Leave for a moment each shelf of books, close every

appalling dictionary of information, and ask, What is Linnæus' secret, what Cuvier's, Goethe's, Von Baer's? Their results are infinite, are endless; but their method simple. Each opened a treasure-house of new ideas too vast for any man to carry; but this with the very simplest key, which is henceforth at the service of each and all. In all Linnæus, what is the secret—the logical principle—the key? Only this—isolate your organism, observe its outward form, describe and name it, catalogue and index it; as far as possible also preserve and draw. But practice upon our common flora is all we need to do this, right through the world.

Would we next descend to Cuvier's plane? What have we? First, the Linnæan secret over again applied to the parts of the organism instead of the whole—isolate, observe, describe, and record as before, but now with the addition, *compare* as well. This, too, can be soon adequately learned in practice, and we are henceforth comparative anatomists in a special group or field.

Next, we have to widen our conception of resemblances in structure, and unify with Goethe the parts of the flower with the leaf, or the strangely modified jaws of an insect with its walking limbs. Thus we have built up the whole intellectual key with which Owen, for instance, has unlocked so many secrets; while, when we add to this the embryological conception of Von Baer, we are modern comparative anatomists complete.

(To be continued.)

THE FOOD AND CLOTHING OF CHILDREN BEYOND INFANCY.

BY HELEN M. WILSON, M.B.

So much has been said and written about babies that there is now no excuse for ignorance about them; but there is, perhaps, rather a tendency to think that as soon as the child can speak and make known its wants, its bringing up is a very simple matter. The age I am going to refer to (roughly, from 2 to 14) needs just as careful and thoughtful watching as babyhood; mistakes do not always bring such swift and evident punishment as they do at an earlier age; but they are at least as pernicious, and their fruits may show themselves throughout life. Everyone knows how immensely important these years are in the moral development, but, physically, they are even more momentous. A mistake in moral training now may possibly be corrected later, for moral growth and development go on through the whole life; but most of the physical growth is concentrated in these years, and any organ which is starved or cramped now will never make it up, but will be a source of weakness through life.

I shall not attempt to cover the whole ground of hygiene during this period. Exercise, fresh air, sleep, are of the utmost importance, but somehow or other children do usually manage to take care of these matters for themselves. For food and clothing, they are absolutely dependent on their elders, and there seems in these departments more scope for mistakes.

Beginning with Food, the chief question is how best to supply material to meet the expenditure of energy so evident in the constant mental and bodily activity of a young child, and to build up the different parts of the growing organism. At the same time, every thoughtful mother must recognise that here moral training cannot be neglected: this is the first appetite that develops, and it cannot too soon be brought